Central Air Conditioners and Heat Pumps
Production Costs: Revisions to Reverse Engineering Analysis
U.S. Department of Energy
June, 2000

The Supplementary Advance Notice of Proposed Rulemaking (SANOPR) included estimates of the production cost of 3-ton air conditioners and heat pumps based on reverse engineering analysis conducted by the Department. The SANOPR also listed production cost multipliers relative to baseline (10 SEER) units provided by the industry through the Air Conditioning and Refrigeration Institute (ARI) and noted that the industry and the reverse engineering cost data yield significantly different LCC, payback period, NES, and NPV results. This difference was raised as an issue for public comment. Responses to the Department varied considerably regarding the continued and proper use of the reverse engineering and the industry data in the analysis. The focus of this report is to summarize revisions to the reverse engineering production data for possible use in Rulemaking analyses.

While the comments received generally supported the reverse engineering approach used to estimate the production costs of split air conditioners, several noted that heat pumps and packaged equipment received less rigorous treatment. The incremental production cost estimates for those three product classes were less consistent than were those for split air conditioners.

The Department agrees that the reverse engineering analysis on heat pumps and packaged equipment was not performed to the same level of rigor as for split air conditioners, and that the results for those classes are therefore less certain. To address those concerns, the Department has undertaken a new analysis which estimates the production cost of split heat pumps and packaged equipment based on the results of the split air conditioning reverse engineering analysis.

In this new approach, the Department applied "rules-of-thumb" suggested by Mr. Joseph Pietsch in an independent review, Docket Comment 36, October 30, 1999, The guidelines are:

1. A split air conditioning fancoil system and cased coil system will share the same outdoor unit.
2. A split air conditioning fancoil system and split heat pump will share the same indoor unit.
3. A packaged air conditioner and packaged heat pump will share the same cabinet.
4. A split air conditioner and packaged air conditioner will share the same functional parts.
5. A split heat pump and packaged heat pump will share the same functional parts.
6. The cost differential between a split air conditioner with fancoil and a split heat pump, and a packaged air conditioner and a packaged heat pump, should be consistent across efficiency levels.

These guidelines are valid only for a particular manufacturer's product line and do not hold across

product lines or across manufacturers. Since the reverse engineering sample contained several manufacturers and product lines, applying these rules has the effect of minimizing any variability and bias introduced by the sample set. The approach also allows us to estimate the production costs of equipment at efficiency levels where we did not have any samples originally. We assessed only through 15 SEER to cover the range of relative cost estimates provided by ARI.

Figure 1: Relationship of Production Cost Estimates in New Reverse Engineering Approach

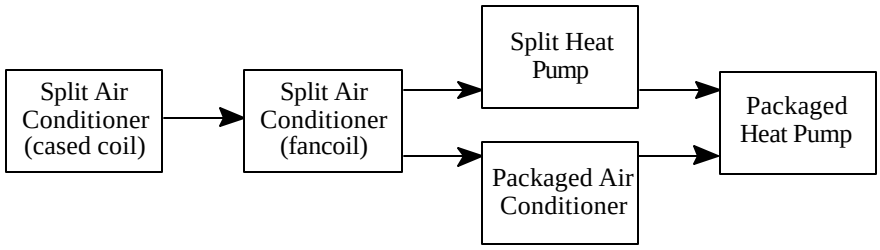

Figure 1 illustrates how the split air conditioner (cased coil) is used to derive the production cost estimates for the other products. At each stage, common costs are translated to the next product, and any missing costs are filled in using results from the original reverse engineering analysis.

Table 1 provides the cost estimates resulting from this new approach. Results do not include any potential cost reduction due to emerging technologies, which are also under revision. Revised results are generally lower than the original results, particularly at the baseline 10 SEER level. The most significant change is that the new analysis includes nine additional estimates that were not presented originally due to lack of data.

Table 1: Revised Reverse Engineering Production Cost Estimates for 3-ton Unitary Equipment

Efficiency Level (SEER)	Split Air Conditioner (cased coil)		Split Air Conditioner (fancoil)		Split Heat Pump		Packaged Air Conditioner		Packaged Heat Pump	
	Original	Revised	Original	Revised	Original	Revised	Original	Revised	Original	Revised
10	$367	$367	$456	$449	$622	$572	$552	$511	$643	$593
11	$412	$412	$550	$519	--	$602	--	$555	--	$638
12	$468	$468	--	$563	$690	$648	$627	$595	$708	$668
13	$529	$529	$756	$637	$840	$743	$809	$730	--	$820

14	$588	$588	$802	$815	$1,011	$1,023	--	$889	--	$1,029
15	--	--	$893	$893	$1,147	$1,107	--	$955	--	$1,100

Table 2 compares the results relative to the 10 SEER unit in each product class. Most revised results are similar to the original results. The only significant departures are found in split air conditioners with fancoils, where the new estimates are lower, and in 14 SEER and 15 SEER equipment where the new results are higher.

Table 2: Revised Reverse Engineering Production Cost Multipliers for 3-ton Unitary Equipment

Efficiency Level (SEER)	Split Air Conditioner (cased coil)		Split Air Conditioner (fancoil)		Split Heat Pump		Packaged Air Conditioner		Packaged Heat Pump	
	Original	Revised	Original	Revised	Original	Revised	Original	Revised	Original	Revised
10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
11	1.12	1.12	1.21	1.16	--	1.05	--	1.09	--	1.08
12	1.28	1.28	--	1.25	1.11	1.13	1.14	1.16	1.10	1.13
13	1.44	1.44	1.66	1.42	1.35	1.30	1.47	1.43	--	1.38
14	1.60	1.60	1.76	1.82	1.63	1.79	--	1.74	--	1.74
15	--	--	1.96	1.99	1.84	1.94	--	1.87	--	1.86

The Technical Support Document accompanying the Notice of Proposed Rulemaking will provide additional details on all aspects of the revised reverse engineering analysis.